NATURAL REGENERATION OF BEECH ABROAD AND IN ENGLAND

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SUMMARY

The contrast between the ease with which regeneration of beech is obtained in some forests on the Continent and the difficulties experienced by foresters in this country leads to the question: to what extent would Continental methods be successful here? In an attempt to answer this question the author examines the methods under which beech is so successfully regenerated in Europe, and discusses the lessons to be learnt therefrom, with a view to solving some of the problems which confront foresters in this country, particularly in the Chilterns, where the regeneration of beech is at present the subject of a detailed investigation by the Forestry Commission.

The proposals recently made by the Forestry Commission concerning the Chilterns have caused some discussion of the problems of their silviculture; and in particular those of the natural regeneration of beech. The contrast between the apparent ease with which it regenerates on the Continent and the rarity of natural regeneration in this country is indeed so remarkable that we may well ask to what extent the Continental methods would be successful here.

On the Continent beech ranges from the lowlands, where it may grow pure or mixed with oak and hornbeam, to high altitudes in the mountains, where it is often mixed with spruce and silver fir; in some mountain districts (Vosges, Auvergne, Balkans) beech forms the upper limit of forest. Although beech enjoys a basic soil and is favoured by it in the lowlands at the expense of sessile oak, it is by no means confined to calcareous soils; for example, in the Vosges and the Black Forest it grows luxuriantly on granite, though it is much less vigorous on the sandstones.

The beech forests most closely comparable with our own are in Normandy. Here the chalk massifs resemble those of the Chilterns and the South Downs in soils and rainfall, and elsewhere are tertiary soils resembling those of Hampshire, Surrey and Berkshire. The summers, however, are distinctly warmer than with us (mean July temperatures: Oxford, 16.6° C.; Osborne (I.O.W.), 16.6° C.; Dieppe, 17.5° C.; Rouen, 18° C.). The beech in Normandy is in even-aged high forest, and is regenerated by the "shelterwood compartment system," so called because the seedlings are established in the shelter of the mature crop, and fellings for regeneration are made over large blocks consisting of one or more compartments in a single season. Regeneration begins at the age of 160 to 180 years with a "seeding felling"—a heavy thinning in which about half the stems, representing about a quarter or at most a third of the total volume, are removed. This opens the canopy sufficiently to allow beech seedlings to survive for some years. At intervals of four or five years further fellings are made, by which the canopy is gradually opened and ultimately removed from areas where there are enough seedlings. Felling and extraction have to be carried out carefully so as to do as little damage to the seedlings as possible. Usually in 15 to 20 years after three or four such fellings, all old trees have been removed and regeneration is complete. The procedure appears to be simplicity itself, but it is not always equally successful, and the degree of its success depends on several factors.

The best results are undoubtedly obtained when a good crop of seed comes immediately after a seeding felling. If the seed comes just before a seeding felling seedlings are equally numerous, but because no attempt is made to complete the work before germination begins, many are inevitably destroyed. If seed does not come for several years, weeds fill up the ground and it is not possible to obtain such a dense crop of seedlings; the extent of this deterioration depends greatly on the soil and on the amount of ground vegetation existing before felling. On the Continent good seed crops can be confidently expected every few years; in Normandy their frequency is usually said to average every five years, but there may be some seed in intervening years, and in parts of Eastern France and Northern Switzerland they are more frequent, and on the average there is probably some seed every second year.

The ground must be in a receptive condition for seed; the surface should be loose, so that seed is readily buried and on germination its radicle readily penetrates into the ground. If the seed is left exposed on the surface it will probably be eaten; if not eaten, it will probably die from dessication or frost, and even if the seed survives these dangers, the seedling will probably die from drought before its radicle penetrates the soil. A loose surface forms naturally where the litter is sufficient in amount and is decaying freely. The ground should be free from vegetation or have at most a thin carpet of low herbs such as wood sorrel (*Oxalis*) and yellow dead-nettle (*Lamium galeobdolon*) and grasses such as melic (*Melica uniflora*), wood millet (*Milium effusum*) and soft-grass (*Holcus mollis*); indeed, these plants often show that the ground is just right. On the chalk these conditions are obtained most readily where there is a moderately shallow (e.g., 18 in.) loam over chalk, or on moderately base-deficient loams. On heavier, deeper soils, blackberry and coarse herbs are luxuriant and often make regeneration more difficult, and here if seed does not come quickly after a seeding felling, weeds may make it practically impossible to obtain a dense and regular crop of saplings. Usually on such soils the blackberry, which becomes tall and dense after the canopy is first opened, dies down after ten or twelve years, but is ultimately succeeded by bracken, in which natural regeneration is impossible; areas which get to this stage have to be planted.

A hard soil surface may form where litter is blown away, especially on somewhat acid soils, and on dry southern aspects where the canopy has been opened too much. A matted turf of grasses such as "waved hair grass" (*Deschampsia flexuosa*) keeps the seed on the surface and is bad. Too much litter can be just as harmful as too little litter, because the seedling root is unable to penetrate through it to the mineral soil.

It is probable that in the early days of shelter wood regeneration in France the ground was often cultivated at about the time of seed-fall in order to loosen the surface, bury seeds, and destroy weeds. With the increasing cost of labour this practice fell into disuse, and was employed only exceptionally for small blanks which had failed to regenerate otherwise. Since 1948, however, it has been renewed, and large areas have been worked with disc-harrows drawn by tractors. In parts of Denmark and Holland cultivation has long been a normal practice ; often on the more acid soils lime is also added to hasten the decay of raw humus.

In many districts hornbeam is present and regenerates profusely with the beech. Though the hornbeam may have to be kept in check, it is useful when there are insufficient beech seedlings to form closed thickets by themselves, though there may be enough to form a pure crop eventually ; in such cases the hornbeam will fill up all spaces, and form the bulk of the young stand, but will gradually be removed in thinnings.

Rabbits are sufficiently rare in the Continental forests to be of no great importance. They are not absent, and they may become sufficiently numerous in thickets of young regeneration to give trouble in filling up neighbouring blanks, especially as they eat planted saplings in preference to self-sown ones. Grey squirrels are absent.

The same principles regulate the regeneration of beech in no matter what form of stand it is grown. There are many forests in the European mountains where beech is worked by selection fellings, but most of these are protection forests at high elevations or on steep slopes where the maintenance of a continuous cover is more important than either a regular out-turn or high-quality timber ; often also the beech is mixed with the shade-tolerant silver fir. There is little, therefore, to be gained by comparison of English conditions with these. There is probably little lowland forest of pure beech that is intensively worked under the selection system, though this system seems to be suited to the constitution of the tree.

In Switzerland most of the lowland forest of pure beech or of mixtures of beech with several other species is under the " irregular shelterwood system " (*Femelschlag*) ; groups of seedlings are obtained by making gaps which are gradually enlarged until they fuse ; sometimes these gap fellings are combined with heavy thinnings or shelterwood fellings. The process is slow, and it takes 50 to 70 years to regenerate a compartment. Because of this slow rate of progress the crops obtained are not even-aged ; indeed, they sometimes look very like selection forest, and the system represents an intermediate condition between this and even-aged high forest. It is the common practice to devote much care to every stage. For example, patches of ground lying close to trees with a good crop of seed may be hoed up. Natural regeneration is freely supplemented by planting or direct sowing. Groups of other species such as oak, ash, conifers or even cherry and elm are sometimes welcomed or even introduced in order to get variety of produce and to make the best use of all the finer variations in site, and also because some foresters feel that pure stands of beech should be avoided. Groups of regeneration are carefully tended from the stage when saplings are only a foot or two high, so that only straight vigorous plants of desired species take the lead.

The Chiltern beech woods are "selection forest" only in the sense that they are selectively felled; they do not possess the range of size classes nor the carefully regulated output that characterize the managed selection forest of Central Europe, and to apply the same name is misleading. The only principle governing the selection of trees for felling has often been that of their suitability for sale. Counts of rings on stumps show also that the range of ages is often small, and after felling a large tree, smaller hitherto suppressed stems of similar age have grown up to fill the gap. Arthur Young, when writing of Oxfordshire (1794), says that the woods are "drawn occasionally, being never felled all at once," and it "requires some judgment to thin these woods so that the present stock may not hang too much over the seedlings, and that at the same time in a south aspect an injury may not take place by exposing the soil to the sun." Although this passage makes it clear that there was some tradition of working the woods so that regeneration was obtained, it is probably a mistake to think that dense stands of pure beech such as we see to-day have persisted from time immemorial, and to regard their present condition as the result of the degeneration of their traditional management. In the first place much woodland is of relatively recent origin. At the time of the enclosures many common grazings, which may indeed have had scattered trees or thickets, grew up into continuous woodland. Arthur Young makes it clear that the woods were often grazed. In the second place, though they valued the mast for swine, the English formerly had little use for beech except for firewood, and in the seventeenth century firewood was taken from Henley down the Thames to London. The Wycombe furniture industry dates from about 1870. Probably, therefore, felling in beech woods tended to be light, and a very small amount of regeneration has served to fill the gaps. With an annual outturn of timber nearer to that which the site is capable of producing* much more regeneration would be needed. Further, there has probably been much selective felling of oak, a suspicion which is strengthened by the following statement from *Chiltern and Vale Farming Explained* (1745): "It generally happens that where a

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* According to Bourne an average figure for the Chilterns is 60 Hoppus ft. per acre per year. A study of enumerations on the Hampden Estate suggests a figure nearer 40 Hoppus ft. These figures are low compared with corresponding French forests, and probably systematic silviculture of our own woods would increase their productivity appreciably. Sixty Hoppus ft. per acre is about 5.3 cu. metres per hectare; the average yield (including thinnings) from the forest of Lyons (Normandy) is about 7.5 cu. metres per hectare (84 Hoppus ft. per acre).

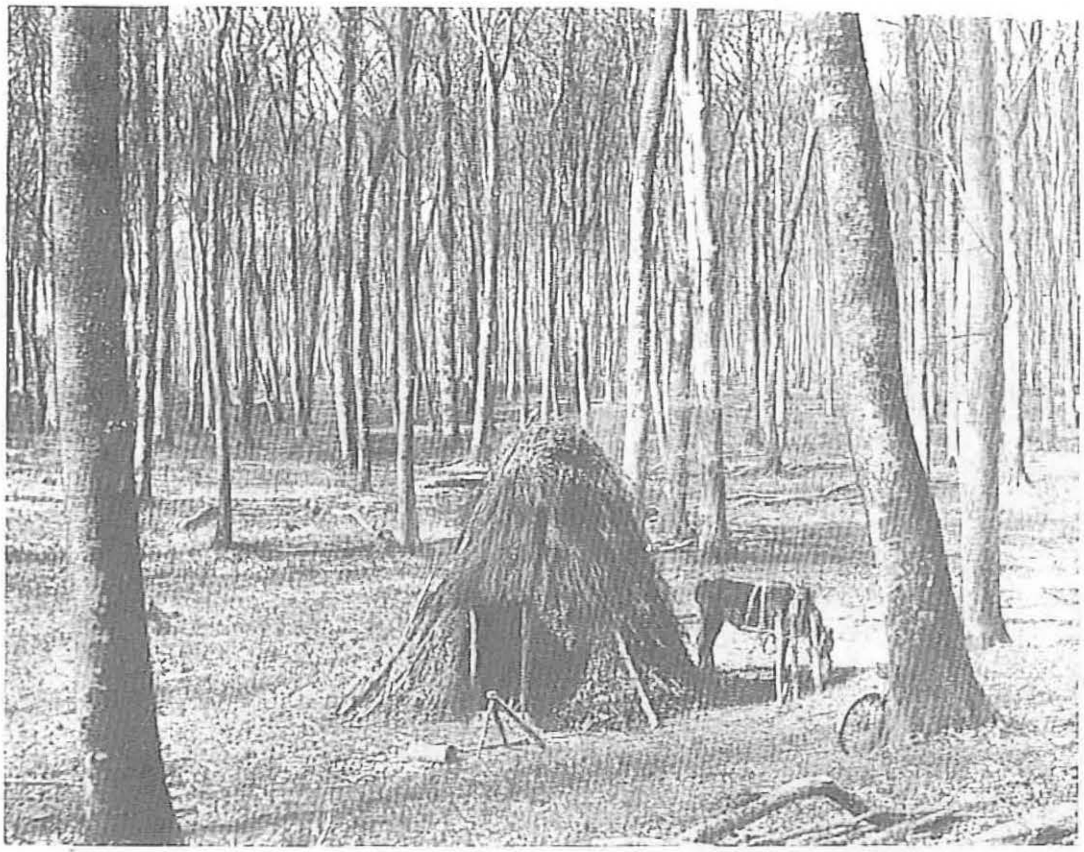

Fig. 1. Seeding felling just completed ; some produce and cordwood yet to be removed ; no seedlings present as yet

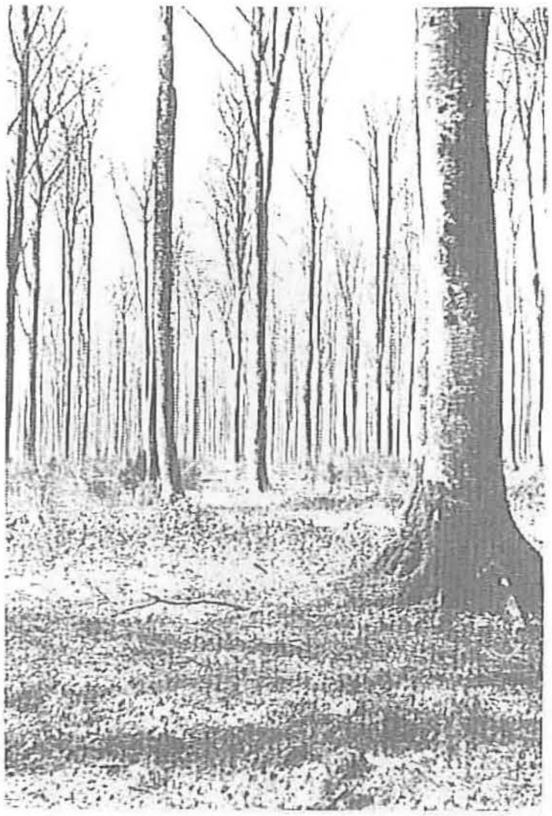

Fig. 2. Mature beech after seeding and one secondary felling ; ground covered with 1 to 4 year old seedlings

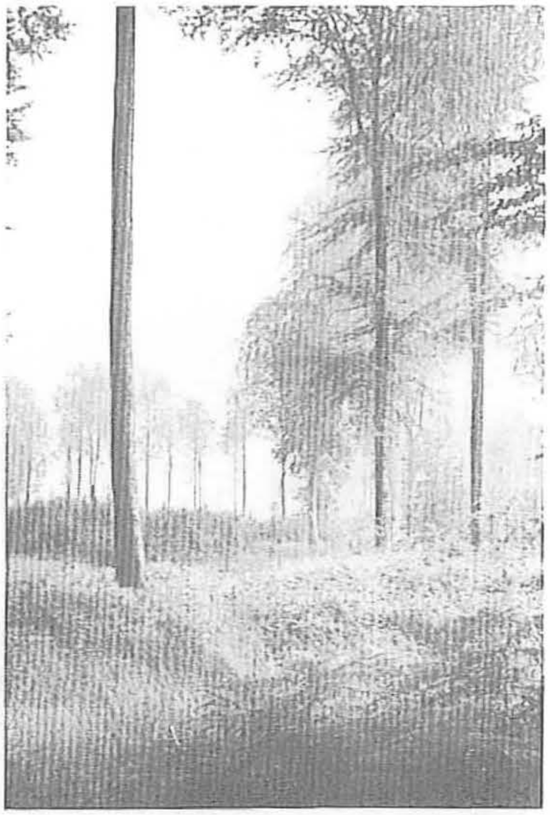

Fig. 3. Later stages of regeneration ; final fellings complete in middle distance ; thickets of saplings to left and in foreground

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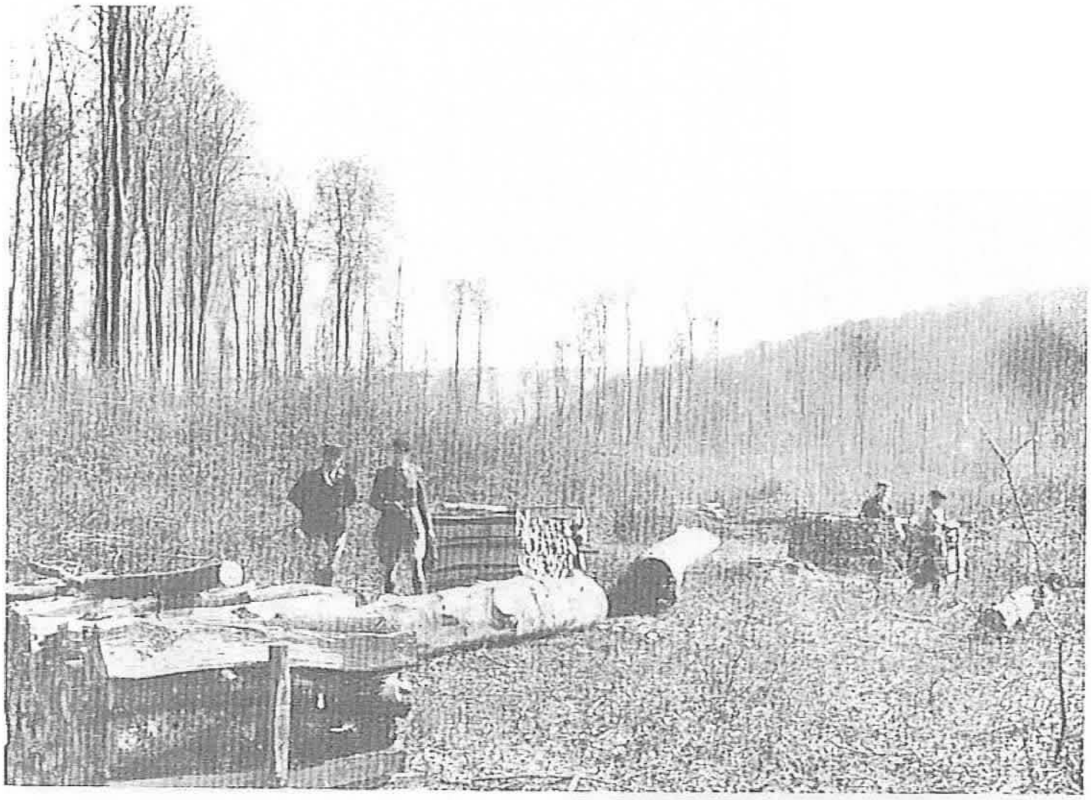

Fig. 4. A late secondary and in places final felling just completed; produce still to be removed

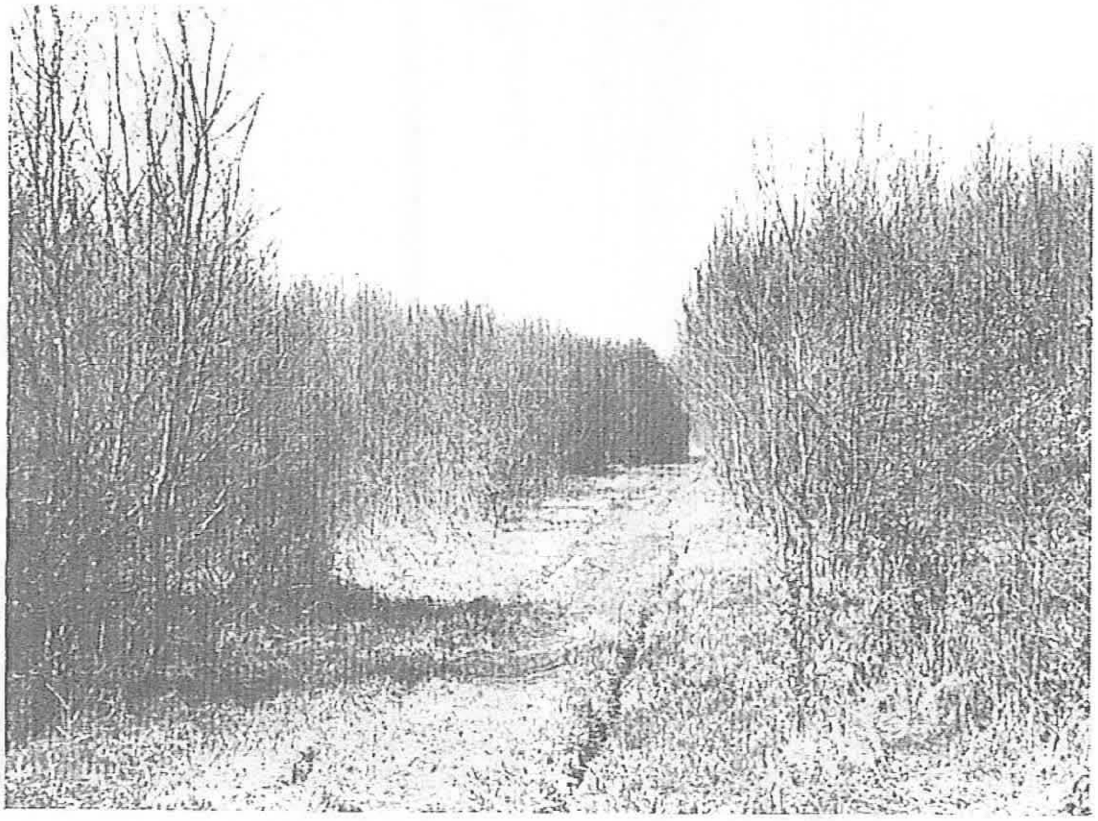

Fig. 5. Regeneration complete; typical 15 to 20 year old stands

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wood of oak has been felled a wood of beech has spontaneously succeeded; and when this has once got dominion it will be sure to remain master."

In the close and regular high forest of the Continent the ground is usually clean and in a condition favourable to regeneration, in strong contrast to its overgrown and unfavourable condition in most English woods. In beech woods, however, the difference is not so great; indeed, where the English beech woods have been underthinned, as is often the case, the floor may be in a better condition than in corresponding Continental woods.

Nevertheless, the abundance of blackberry does constitute a very great obstacle to regeneration in many woods, and a cheap method of eradicating it would be of great value. The effect of cutting or slashing is not very great, and even cultivation needs to be very thorough to reduce it much. Some of the recently developed selective weedkillers might perhaps prove useful in exterminating it. It is one of those paradoxes which are so numerous in silviculture that the thinning which is necessary to produce rapid diameter growth and large crowns capable of giving abundant seed also lets in the blackberry and makes regeneration difficult. In the same way, the more fertile the soil, the greater the degree of shade which such weeds will endure, and the more difficult does regeneration become. A thinning which will let in blackberry and coarse weeds on a moist fertile site may be perfectly safe on a drier or less rich soil; here the danger in opening the canopy arises not so much from weed growth as from hardening of the soil. In the long run the employment of crown thinning with the retention of an understorey of suppressed beech would probably be the most satisfactory way of reconciling the need for keeping a dense canopy with that for thinning sufficiently heavily on the better soils. There is thus plenty of scope for judgment and experience in preparing a stand for regeneration.

In England seed-years of beech are not only less frequent but also more erratic than on the Continent; we cannot rely on seed coming every few years. So far as can be ascertained recent mast years have been as follows: 1890 (general), 1900 (general), ?1906 (Chilterns), 1907 (Chilterns), 1909 (Chilterns), 1912 (general), 1915 (general), 1922 (general—the heaviest mast in living memory), 1935 (very local), 1941 (general), 1944 (general), 1948 (general), 1949 (local). Of these years 1922 alone, which followed the dry summer of 1921, had an outstanding crop, and most of the beech regeneration in the country comes from it. This scarcity of seed is the most fundamental serious obstacle to systematic natural regeneration. It supplies a reason why the Chiltern woods are so often more or less even-aged. There are two principal deductions that we may make from it concerning silviculture. Firstly, the methods of management adopted must be flexible, permitting us to use opportunities to regenerate at short notice. It is no use planning to regenerate a given area in a given year; we must plan to regenerate it at the first opportunity. Theoretically the shelterwood compartment system is ideal under such conditions, for when a seed year comes it is possible to make a seeding felling over areas of unlimited extent. In practice, however, there are difficulties in arranging for the rapid felling and extraction of large amounts of timber at a few months' notice ; indeed, it may be impossible where timber has to be sold standing. The abundance of fat flower buds in winter gives the first indication of the approach of a good mast, but not until June when the fruit is setting can there be reasonable certainty. In 1935 there was an abundance of flower, promising an excellent mast, but it was almost all destroyed by late frost. Secondly, the greatest possible use must be made of relatively light crops of seeds. Cultivation is likely to prove valuable in increasing the proportion of seed which give rise to plants. The practice of felling after the seed has fallen would be helpful not only because trampling and dragging help to bury seed, but because workmen in the woods help to keep away pigeons. The relative scarcity of seed in England makes the scarcity of hornbeam all the more unfortunate, but other species such as ash, cherry or sycamore may take its place to some extent.

About rabbits there is little to be said which has not been said emphatically elsewhere. Though they are less abundant in the Chilterns than in many districts, there are still too many, and one of the most useful practical contributions which the Government could make to any "Chiltern Project" would be to ensure that rabbits were rigorously suppressed not only in the woods but in agricultural land throughout the area. Though the grey squirrel is also a serious pest, his activities do not prevent regeneration, but cause much damage in the pole stage.

Two of the most noteworthy attempts to regenerate naturally in the Chilterns followed the mast of 1922 on the Hampden and the Parmoor Estates. Monckton Wood on the Hampden Estate was very dense, and the seedlings which carpeted the ground in the spring of 1923 persisted to the end of the summer only beneath and around small gaps in the canopy. In the winter of 1923–4 Hobart-Hampden enlarged these gaps and so saved patches of the regeneration. Although there has been no subsequent crop of seedlings of comparable importance, an appreciable number of seedlings from the relatively light crops since 1935 have entered around the margins of the groups where there has been side-light, and it has been possible to enlarge the gaps from time to time, so that the groups now cover several acres. The part of the wood where almost all the regeneration is situated lies on a plateau where the soil is relatively poor and blackberry enters only slowly when the canopy is opened ; the trees are small and of poor form. On the lower slopes of a shallow valley both the crop and the soil are better, blackberry enters much more readily, and there has been regeneration only close to the margin of the wood.

In the autumn of 1923, on the Parmoor Estate, the late Ray Bourne found beech seedlings still surviving over much of the eastern half of Pound Wood. and by thinning heavily during the winter he was able to save them. Apparently the seedlings owed their survival during the first summer to a light fire which had burned through the wood, probably in the summer of 1921. Bourne considered the reduction in the amount of litter its most important effect, but it is possible that the destruction of blackberry, which was dense in parts of the wood, was equally important. Because there were many places where more seedlings were desirable Bourne then waited for another seed year, but filled up blanks from time to time by planting. It was not until 1943–4 that the remainder of the old crop was removed; the average height of the regeneration was then about ten feet, and the old trees were topped before felling, to reduce the damage.

Both these attempts suffered because they were not begun until the winter of 1923–4, by which time most of the seedlings had died. Had a seeding felling been made in the winter of 1922–3 in Monckton Wood there would obviously have been no difficulty in regenerating it completely, and the same is doubtless true of many other Chiltern woods.

Taking advantage of the seed crop of 1944, which was perhaps the best since 1922, Bourne made a number of seeding fellings on other estates in the Chilterns in the winter of 1944–5. In some woods, also, fellings in the early years of the war enabled him to save some seedlings from the 1941 seed. Unfortunately war-time needs had to take priority over silvicultural considerations in determining the exact nature of these fellings, which were as successful as could be expected.

We may now attempt to summarize the position. Seed years in England are so irregular that it is important to wait for a seed year before beginning to regenerate. The forester must be ready to take advantage of a seed year at short notice. "Being ready" entails having stands which are suitable for regeneration—that is to say. stands with mature large-crowned trees, a dense canopy and a clean loose floor, or alternatively with the means of cultivation and eradication of weeds, and no rabbits. It also entails having work so planned that it is possible to delay seeding fellings in such areas until the seed year comes, deriving the yield from other sources (e.g., thinnings, secondary fellings) in the meantime, and organizing labour, sales of timber, etc., so that seeding fellings can be made at short notice, and the site cleared before the seedlings begin to germinate in April. On most estates the difficulties of organization are such that it would be impossible to regenerate more than a small area in any one seed year, and this would go against the use of the shelterwood compartment system as practised in France. A technique of the Swiss type, with the much greater flexibility conferred by irregular crops and regeneration in groups would in many ways be more suitable, though it needs much more skilled and closer supervision. The Swiss forest inspectors spend all their lives in one charge; they know their forests intimately and mark all fellings themselves; on an English private estate a similar degree of care would be possible only where an enthusiastic owner was prepared to acquire the necessary experience and to devote much time to his woods. The Swiss technique also needs much more careful felling and extraction than the French technique, and mechanized cultivation would probably be impossible with irregular crops.

With any method of natural regeneration more care must be given to felling and extraction than is customary in Britain. In France the use of tractors is not permitted once seedlings are on the ground. and horses must be muzzled ; in Switzerland felled trees are commonly pulled to the ride-side by ropes with pulley-block and tackle, so that not even horses enter the young crops. Thus estates might well have to train their own staff for the work, and at the very least felling would have to be supervised by a forester who would say in what direction trees were to be felled and removed. It is unlikely that any timber merchant would be prepared to extract with the Swiss methods ; even in Switzerland the forest staff themselves do the work. Finally, it must not be imagined that natural regeneration costs nothing. There is the cost of planning and organization, and of additional time spent in marking fellings ; the delay of fellings until a seed year may entail some financial sacrifice, and a timber merchant who has to accept restrictions may not offer so high a price for timber. In addition, there is the cost of slower growth when young, and there may also be costs of cultivation and tending. Yet, even if natural regeneration costs as much as planting, good natural regeneration is better than a planted crop, because the stand is so much denser, and the trees correspondingly cleaner and straighter.